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Biomechanical Changes in an Endodontically Treated Tooth - A Review

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ABSTRACT:

The specific biomechanical alterations associated with vitality loss or dentistry procedures ar con- fusing problems for the professional person and are polemically approached from a clinical point of view. The aim of this review is to have the summary of this data concerning the composition changes, structural alterations, and standing following dentistry medical aid and restorative procedures. The Fundamental search method enclosed a scientific review of the PubMed/Medline info between 1990 and 2005, mistreatment single or combined keywords to get the foremost comprehensive list of references; a reading of the references of the relevant sources completed the review. This review has a satisfactory overall with contemporary restorative approach and etc..,but in turn it emphasizes the importance and relevance of in vitro studies to further improve the quality and long term stability of prosthetic foundations.

Keywords:

Non vital teeth; posts and cores; Endodontically treated tooth; Biomechanical changes

INTRODUCTION:

The restoration of endodontically treated teeth has been a great topic, frequently approached empirically and based totally on desired and scientific evidence. The literature evaluates present modern understanding about the changes in the tissue structure following the endodontic therapy and the activity of restored enamel in monotonic mechanical assessments or finite detail analysis (Helfer, Melnick and Schilder, 1972)(Gutmann, 1992). Only little variations in the dentin micro hardness or hardness had been seen in between important and non-vital dentin(Lewinstein and Grajower, 1981)(Sedgley and Messer, 1992). This restorative technique can also have an impact on the steadiness of nonvital teeth; with nonadhesive techniques, a complete occlusal coverage recovery (Reeh, Douglas and Messer, 1989)(Assif *et al.*, 2003). was also assessed to conserve the remaining shape.(Ramamoorthi, Nivedhitha and Divyanand, 2015; Ramanathan and Solete, 2015) In general, the administration of composite resin in conjunction with less inflexible fiber posts was seemed to be the most effective technique for the healing of grossly decayed nonvital tooth, in attention of still-perfectible adhesive procedures(Eskitascioglu, Belli and Kalkan, 2002)(Maccari, Conceição and Nunes, 2003)(Akkayan and Gülmez, 2002). The latter alternative method had greater impact in opposition to root fractures. During the simulation of first rate cohesive interfaces (with detail analysis), inflexible posts have shown a greater decrease in stress within the critical cervical area(R, Rajakeerthi and Ms, 2019; Siddique *et al.*, 2019) (Pierrisnard *et al.*, 2002). In general, rigid ceramic or steel posts generally tend to distribute internal stress or to switch them more apically (leading to possibility to greater failures), whereas the use of softer fiber posts with composite resin also have same tendency to pay attention to stress along the adhesive interface but also to change them equally during the enamel and its surrounding tissues(Pegoretti *et al.*, 2002; Rajendran *et al.*, 2019a) . The above mentioned facts and conclusions are not complete, but they doesn't think about any specific strains of the oral cavity

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regarding cyclic forces (referred to as fatigue), which eventually add up the most of clinical failures (Torbjörner and Fransson, 2004; Dietschi *et al.*, 2007).

Our team has rich experience in research and we have collaborated with numerous authors over various topics in the past decade (Ariga *et al.*, 2018; Basha, Ganapathy and Venugopalan, 2018; Hannah *et al.*, 2018; Hussainy *et al.*, 2018; Jeevanandan and Govindaraju, 2018; Kannan and Venugopalan, 2018; Kumar and Antony, 2018; Menon *et al.*, 2018; M. P. Manohar and Sharma, 2018; Nandakumar and Nasim, 2018; Nandhini, Babu and Mohanraj, 2018; Ravinthar and Jayalakshmi, 2018a; Seppan *et al.*, 2018; Teja, Ramesh and Priya, 2018; Duraisamy *et al.*, 2019; Gheena and Ezhilarasan, 2019; Hema Shree *et al.*, 2019; Rajakeerthi and Ms, 2019; Rajendran *et al.*, 2019b; Sekar *et al.*, 2019; Sharma *et al.*, 2019; Siddique *et al.*, 2019; Janani, Palanivelu and Sandhya, 2020a; Johnson *et al.*, 2020; Jose, Ajitha and Subbaiyan, 2020).

Tissue composition:

The changes in the physical structures of the ultimate hard dental tissues is considered by the way of many dentists, however there is no characteristic evidence to preserve this great opinion. The structural differences of the dentinal collagen has over incomplete bindings can be observed into the collagen of non-vital teeth as compared to the vital ones. The loss of vitality is assessed by changing an alternative in the content of moisture in the tooth, which is combined by changing the content of moisture in the enamel (Helfer, Melnick and Schilder, 1972; Sedgley and Messer, 1992), that also has a little influence on the young's modulus and its proportional limit (Guttman, 1992; Huang, Schilder and Nathanson, 1992). Hence the comprehensive and tensile strength remains the same though the water content is altered . This loss of moisture is attributed to trade in water content but not in bonded water.(Kumar and Delphine Priscilla Antony, 2018; Nasim *et al.*, 2018; Ravinthar and Jayalakshmi, 2018b)

Sodium hypochlorite and some chelators such as EDTA, and CDTA, are used commonly for the purpose of canal irritation, with root dentin, either with the mineral content or the natural substrate (Nikiforuk and Sreebny, 1953; Helfer, Melnick and Schilder, 1972; Hülsmann, Heckendorff and Lennon, 2003). Sodium hypochlorite shows proteolytic action with tremendous fragmentation and the aid of lengthy peptide chains composed of collagen (Shinohara *et al.*, 2004)

While reviewing the mechanical residences of human's dentin as said in literature over the last fifty years, Kinney et al. And also defined in 2003, and discovered extraordinary values , and reinterpreted the records to finish the Young's modulus of elasticity for dentin, that lies among 18-25 GPa. This part went on by comparative values of the elastic modulus with the preceding research, aids in calculating the micromechanical version in place of formerly used mathematical versions . It also states that the dentin is viscoelastic, i.e. the dentin exhibits a time structured reaction to the stress and its anisotropic components. Other researchers also concur with this finding . Young's modulus is defined as the minimal inside the direction of the dentinal

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tubules and improved monotonically to highest at the plane of the mineralized collagen fibrils. The collagen fibrils run perpendicular to the shape of the dentinal tubules. Normal dentinal tubules run perpendicular to the outer surface of the tooth. Noted that; due to multiple techniques which the modulus is measured by means of , distinctive values were mentioned . This examination determined the viscoelastic behavior of dentin, and explains the differences in elastic modulus values acquired between resonant ultrasound spectroscopy and the atomic force microscope (AFM) the use of nanoindentation methods. The advantage of this method is that it has the ability to measure one after another in various additives of dentin or enamel in a wet environment, which is essential to the reporting of correct values, as dehydrated dentin has a greater elastic modulus and is, therefore, greater brittle. This is drastically greater than values which are mentioned before (13-16GPa) and it is regular with values that are given for bone.

Dentin physical characteristics:

Dentin microhardness and its elasticity varies in between the peritubular and intratubular dentin and struck by the location which is present in the tooth (Meredith *et al.*, 1996; Hawkins, Rees and Davies, 2002). Greater difference in the compressive strength varies with tubule orientation(Herr *et al.*, 1981). The literature however no longer confirm and ease the influence of tissue maturation/growing order and connected with the tubule regarding the diameter and range that has no dentin physical properties (Palamara *et al.*, 2000; Lertchirakarn, Palamara and Messer, 2001).For several years, it has became a thought that the physical properties are expressed for dentin and enamel as if the structures though the systems which were isotropic. Acknowledging the classical research (Craig and Peyton – 1958) measuring the elastic and mechanical residences of dentin. With the previous research, it was discovered that the storage medium of the tooth specimens tested for mechanical properties has notably affected the measurements that have been taken. Localizing this is notable because it questions the final results of a lot from the previous research. Habelitz et al. discovered in 2002 that storing samples for testing in deionized water or CaCl2 solution, dramatically reducing the elastic modulus and the hardness of those samples because it altered their calcification. Storage in a medium of Hank's Balanced Salt Solution (HBSS - contains various quantities of KCl, KH2PO4, NaCl, NaHCO3, Na2HPO4, CaCl2, MgCl2, and D-Glucose, and may contain phenol red) for a time up to 2 weeks showed no alteration in the outcomes, whereas storage in the other mediums lowered the mechanical properties to 50% in 2 weeks. This is considerably above the range because of the testing techniques which affected the samples so much that they did not behave as "vital" teeth did.

No or only minimal variations in micro hardness values were found between vital and non vital dentin of contralateral teeth after 0.2 to 10 years . The (Carrigan *et al.*, 1984)literature does not assist an extensively held short that the attributed the weakness or brittleness of the non vital dentin. In such condition the volume discount in, secondary or tertiary discount of pulp that

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reasons decreased fracture resistance of aged, non vital teeth(Noor, S Syed Shihaab and Pradeep, 2016; Teja, Ramesh and Priya, 2018; Janani, Palanivelu and Sandhya, 2020b).

On the contrary disinfectants like Eugenol, and formocresol improved dentin tensile strength via protein coagulation and chelation with hydroxyapatite hardness , but now not influenced by using the later products.

Fracture resistance and tooth stiffness:

The greater adjustments regarding the biomechanics of the tooth is attributed to loss of enamel tissue followed by the caries lesion , fracture, or cavity preparation, including the accessing into the cavity before endodontic therapy. The reduction of tooth structure all through conservative access cavity preparation practice influences teeth stiffness by only 5%, the influence of subsequent canal instrumentation and obturation either led to a reduction in the resistance to fracture regarded to have changes regarding tooth biomechanics.
The more availability in tooth stiffness is due to excess preparation, especially the loss of marginal ridges, normally the other review says that it is in the range of 14%-44% and 20%-63% reduction in tooth stiffness followed by occlusal and mesio occluso distal cavity preparation.

The canal preparation has impact on its biomechanics proportional to the quantity of tissue removed and probably also with the aid of chemically or structurally alteration prompted by using endodontic irrigators (Hülsmann, Heckendorff and Lennon, 2003). The cavity depth, isthmus width, and configuration are then highly critical factors in determining the discount in tooth stiffness and threat of fracture (Hood, 1985) .The ferrule effect and larger amount of residual tissue in general provided to increase enamel resistance to fracture. Actually a minimum of 1mm ferrule is considered necessary to stabilize the restored tooth (Sorensen and Engelman, 1990). The width of the shoulder and crown margin do not appear to steer the fracture strength (Al-Wahadni and Gutteridge, 2002).

Although specialised proprioceptors could not be diagnosed in the dental pulp, there may be evidence of A-β nerve fibres presence which have good documented proprioceptive functions. Therefore, the altered sense notation of occlusal forces in non-vital teeth may additionally produce discomfort simplest when attaining the double values of the functional occlusal load for the vital teeth.

Together with the training of an access cavity, canal enlargement during endodontic procedures technically, and use of specific chemicals, all of which significantly reduce tooth power, aforementioned concept may provide an explanation for the higher rate of mechanical failure of endodontically treated teeth, in comparison to the vital ones.

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Physicochemical properties of restorative materials:

Our institution is passionate about high quality evidence based research and has excelled in various fields ((Pc, Marimuthu and Devadoss, 2018; Ramesh *et al.*, 2018; Vijayashree Priyadharsini, Smiline Girija and Paramasivam, 2018; Ezhilarasan, Apoorva and Ashok Vardhan, 2019; Ramadurai *et al.*, 2019; Sridharan *et al.*, 2019; Vijayashree Priyadharsini, 2019; Chandrasekar *et al.*, 2020; Mathew *et al.*, 2020; R *et al.*, 2020; Samuel, 2021)

In an in vitro look at analysing the physical residences of diverse posts, it became performed that the proper post layout contains a cylindrical conical element and a conical apical element (Lambjerg-Hansen and Asmussen, 1997). However there may be no minimum physical requirements for post or restoration of a non vital tooth abutment .(Jose, P. and Subbaiyan, 2020).Considering the physico-chemical properties of sodium hypochlorite when in touch with organic tissue, these reactions can be verified. Sodium hypochlorite is a strong base (pH>11). At 1% concentration, sodium hypochlorite presents a surface tension same to 75 dynes/cm, identical to 0.986 cP, 65.5 mS of conductivity, 1.04 g/cm3 of density and moistening capacity same to at least 1 h and 27 min.

Sodium hypochlorite alters the natural substrate of dentin and reveals a proteolytic action. Depletion of the organic section becomes confirmed through infrared spectroscopy . This is assigned to widespread fragmentation of long peptide chains, along with collagen, mainly to a lowered modulus of elasticity and flexural strength of dentine.

Chelators which includes ethylene-diamine tetra-acetic acid (EDTA), 1,2cyclohexane-diamine tetra-acetic acid (CDTA), and ethylene-glycol-ether diamine tetra-acetic acid (EGTA), as well as calcium hydroxide, extensive used for canal irrigation and disinfection, have interaction with the mineral content of dentin. The end result is dentin erosion and softening, is due to the fact they mainly use up calcium through complicated formation and also have an effect on non-collagenous proteins: proteoglycans, dentin phosphoproteins and sialoproteins.

Fracture resistance, tooth stiffness and other monotonic mechanical tests:

With casts posts and cores, a unique adaptation will increase fracture resistance however at the same time it damages the root, leading to tooth extraction. In a metallic recuperation on endodontically handled teeth, masking the cusps proves to improve the fracture resistance and tooth stiffness. It is not yet considered appropriate to repair endodontically treated teeth having 2-3 surface cavities with a conservative method without cusp coverage (Reeh, Messer and Douglas, 1989). Comparison of fracture resistance of teeth restored either with zirconium ceramic or resin fiber posts revealed an excessive fracture resistance of teeth restored with fiber posts in addition , teeth having ceramic posts failed in particular following put up and root fractures, whether the specimens showed simplest fractures of coronal reconstruction. Newman

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mentioned that the resistance of the fractured teeth restored with gold posts was advanced to the ones restored with metal posts, parallel posts also show extra benefit in appreciation to tooth fractured patients.(Nasim *et al.*, 2018)
Below the overall prosthetic reconstruction, titanium posts with composite centre showed the highest resistance to fracture, observed by the aid of quartz fibre and glass fiber posts, with zirconium posts showing lower resistance. Catastrophic failures have been found best while the stiffer metal and ceramic posts have been used. (Nandakumar and Nasim, 2018)

Monotonic tests were designed to access the influence of various substances and restorative strategies on tooth, resistance to excessive stress (Bates, Stafford and Harrison, 1976), this approach mimics very precise sorts of failure types or stresses together with ones determined in trauma, below abutments of removable dentures or posts and cores during the elimination of provisional crown. In maximum clinical failures resulting in material and tissue breakdown or interface separation may be ascribed to physiologic mastricatory or parafunctional forces when repeated over long durations of time.(Rajendran *et al.*, 2019a)

Cleaning and shaping the basis root canal system diminishes teeth stiffness proportional to the amount of eliminated tissue and it is far possible associated with the chemical or structural alteration introduced by the way of endodontic chemical products.(Teja and Ramesh, 2019) Despite lack of clean evidence, absence of the dental pulp may eventually lead to loss of some of the mechanical responsiveness of the tooth, diminishing its proprioceptive sensitivity.

CONCLUSIONS AND TREATMENT RECOMMENDATIONS:

The effect of the vitality loss appears to be negligible concerning moisture or physical properties of dentin along with micro hardness, modulus elasticity and fracture toughness. Changes in tubule density were pronounced specially by the way of root degree and tooth age.(M. Manohar and Sharma, 2018) The preparation of cavity and canal extension , use of chemical substances and post placement , however, likely reduces tooth strength. Preserving the intact tooth structures, maintaining cervical dentin in a non vital tooth.The preparation of access cavity, canal enlargement during endodontic procedures and use of particular chemicals, however, significantly reduce tooth strength. In fact, tooth conservation is the most difficult aspect while managing a non vital tooth. Preserving the intact structures of the teeth, is essential to optimize the biomechanical behavior and to increase the fracture resistance of the restored endodontically treated tooth.

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